A Minimally Invasive Treatment for Lumbar Disc Herniation: DiscoGel® Chemonucleolysis in Patients Unresponsive to Chemonucleolysis with Oxygen-Ozone

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Summary

A multitude of therapies is available to treat disc herniation, ranging from conservative methods (medication and physical therapy) to minimally invasive (percutaneous) treatments and surgery. O_2-O_3 chemonucleolysis (O_2-O_3 therapy) is one of the minimally invasive treatments with the best cost/benefit ratio and lowest complication rate. Another substance recently made available exploiting the chemical properties of pure ethanol is DiscoGel®, a radiopaque gelified ethanol more viscous than absolute alcohol [8,9]. The present study aimed to assess the therapeutic outcome of DiscoGel® chemonucleolysis in patients with lumbar disc herniation unresponsive to O_2-O_3 therapy.

Thirty-two patients aged between 20 and 79 years were treated by DiscoGel® chemonucleolysis between December 2008 and January 2010. The treatment was successful (improvement in pain) in 24 out of 32 patients.

DiscoGel® is safe and easy to handle and there were no complications related to product diffusivity outside the treatment site.

The therapeutic success rate of DiscoGel® chemonucleolysis in patients unresponsive to O_2-O_3 therapy was satisfactory. Among other methods used to treat lumbar disc herniation, DiscoGel® chemonucleolysis can be deemed an intermediate procedure bridging conservative medical treatments and surgery.

Introduction

Myriad therapies are available to treat disc herniation, ranging from conservative methods (medication and physical therapy) to minimally invasive (percutaneous) treatments and surgery.

A wide range of minimally invasive percutaneous treatments for lumbar disc herniation have been implemented in recent years: chemodiscolysis with chimopapain; Onik's automated percutaneous lumbar discectomy (APLD); percutaneous laser disc decompression (PLDD); intradiscal electrothermal therapy (IDET); percutaneous coblation nucleoplasty; Dekompressor percutaneous lumbar discectomy; intradiscal oxygen-ozone (O_2-O_3) therapy.

O_2-O_3 chemonucleolysis (O_2-O_3 therapy) is one of the minimally invasive treatments with the best cost/benefit ratio and lowest complication rate (<0.1%) [6]. Our Neuroradiology Service obtained good outcomes with this treatment in 74.3% of patients with lumbar disc herniation [3].

Another substance recently made available exploiting the chemical properties of pure ethanol is DiscoGel®, a radiopaque gelified ethanol more viscous than absolute alcohol [8,9]. The present study aimed to assess the therapeutic outcome of DiscoGel® chemonucleolysis in patients with lumbar disc herniation unresponsive to O_2-O_3 therapy. The rationale of this proposal is based on the fact that Ethanol shows a more

lytic effect in comparison with Ozone. For this reason we thought interesting to propose DiscoGel® to the patient non responding to Ozone.

Materials and Methods

Thirty-two patients aged between 20 and 79 years were treated by DiscoGel® chemonucleolysis between December 2008 and January 2010.

Inclusion criteria for DiscoGel® chemonucleolysis were:

Clinical criteria:

- Lumbago, cruralgia and sciatica lasting at least three months and resistant to conservative management, medication and physical therapies; sometimes in association with paraesthesiae;
- Poor therapeutic outcome following O_2-O_3 therapy performed at least six months before DiscoGel® treatment;

Neuroradiological criteria (CT and/or MR):

- Imaging findings of one or more small or medium uncalcified disc herniations in a location congruent with symptoms, complicated or not by degenerative disc disease;

Exclusion criteria for treatment with O_2-O_3 and DiscoGel® were:

- Neuroradiological evidence of calcified herniation or free disc fragments;
- Major neurological deficit with impaired lower limber motility congruent with observed disc disease (this criterion is an indication for surgery).

Fifty discs were treated in 32 patients. One disc level was treated in 19 patients, two levels in eight patients, and three levels in five patients. The treated intersomatic discs were: two L1-L2, four L2-L3, eight L3-L4, 19 L4-L5 and 17 L5-S1 (Table 1). All patient were treated on a day hospital basis.

Disc puncture was performed with a 22G × 15 cm spinal needle (Figure 1) under fluoroscopic guidance using a GE ADVANTAGE 3D XR 2.0 digital biplane angiography system. An extraspinal lateral approach was always adopted with the patient in lateral decubitis (Figure 3A,B). The final position of the needle was documented in AP and LL radiograms. No premedication or anaesthesia was administered to any patient to avoid masking any symptoms arising from the needle coming into contact with the nerve root. We did never try a transthecal approach, but always the postero-lateral. Access to the disk is usually easy with straight needles. At L5-S1 it is possible to find difficulties due to the pelvis morphology. The use of a thin, flexible needle helps in reaching the good position inside the disk nucleus.

DiscoGel® was provided by the manufacturer in a kit containing a 2 ml solution for injection with two disposable 1 ml syringes each for single use (Figure 2). The amount of DiscoGel® injected into each intersomatic disc ranged from 0.5 ml to 0.8 ml depending on the amplitude of the disc space and the relative capacity of the disc to accommodate the gel (Figures 4-6).

After treatment patients were placed in supine decubitus and invited to rest in that position for two hours. On discharge from the day hospital in the afternoon patients were instructed to resume work, sport and leisure activities gradually. All patients subsequently underwent clinical follow-up at three-four weeks, two months and six months after treatment.

Previous O_2-O_3 therapy constisted in an intradiscal (4 ml) and periganglionic (8 ml) injection of an O_2-O_3 mixture at an ozone concentration of 27 µg/ml. In addition, patients received a periganglionic injection of corticosteroid (1 ml

Table 1 **Summary of treated discs.**

50 discs in 32 patients	
19 pts: 1 disc level	L1-L2: 2
8 pts: 2 disc levels	L2-L3: 4
5 pts: 3 disc levels	L3-L4: 8
	L4-L5: 19
	L5-S1: 17

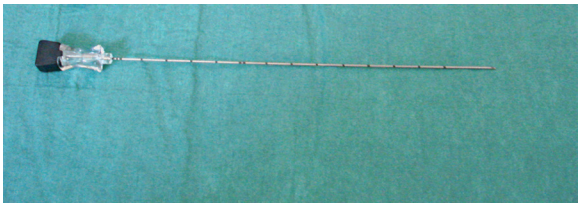

Figure 1 22 G × 15 cm spinal needle.

Figure 2 1 ml DiscoGel® syringe.

Table 2 **Modified MacNab method for the assessment of treatment outcome.**

Success	Failure
Excellent: • Disappearance of symptoms • Full recovery of physical activity *Good:* • Occasional low back pain or sciatica episodes • No limitation on physical activity *Satisfactory:* • Improvement of symptoms • Limited physical activity	*Mediocre:* • Insufficient improvement of symptoms • Periodic need for medication • Limited physical activity *Poor/surgery:* • No improvement of symptoms • Recourse to surgery

Table 3 **Therapeutic outcome six months after treatment.**

Success 75%		Failure 25%	
Excellent/ Good	Satisfactory	Mediocre	Poor/ Surgery
14 (43.8%)	10 (31.2%)	5 (15.7%)	3 (9.3%)

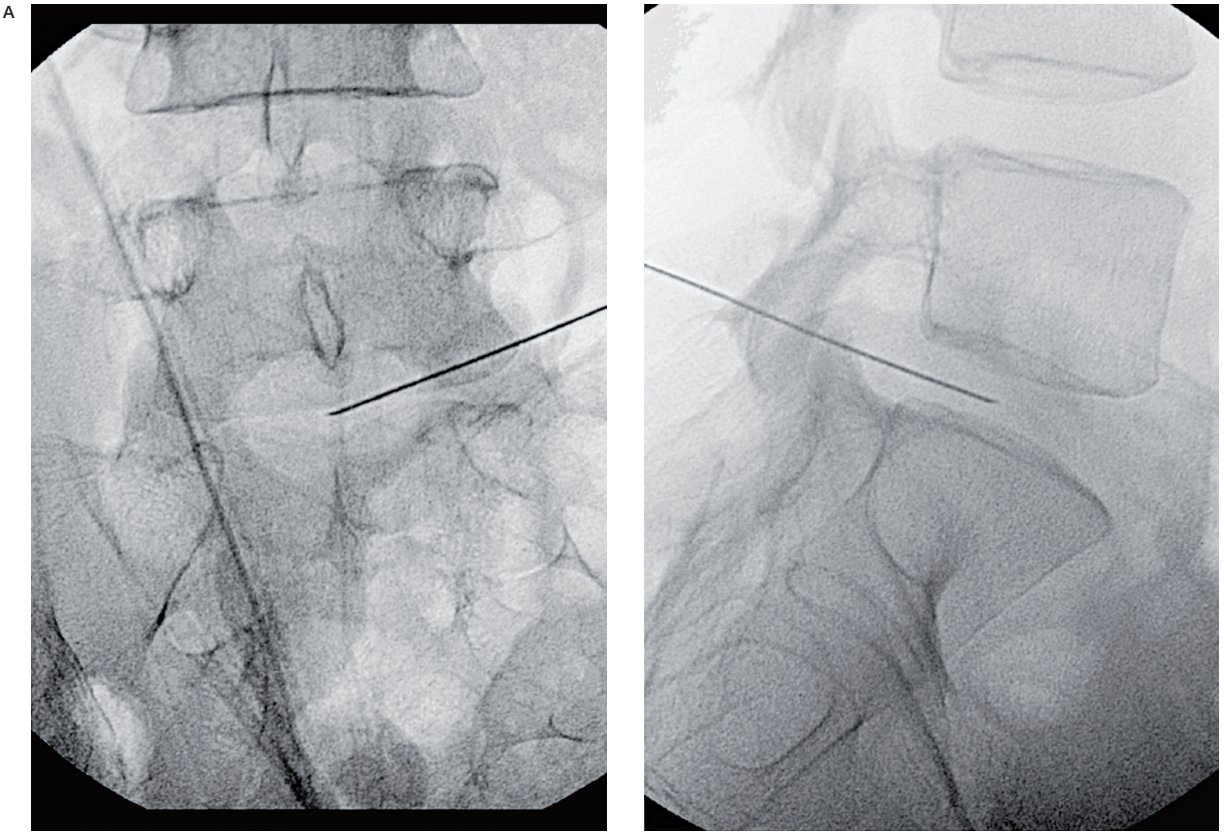

Figure 3 A,B) Lumbar intersomatic disc puncture under fluoroscopic guidance.

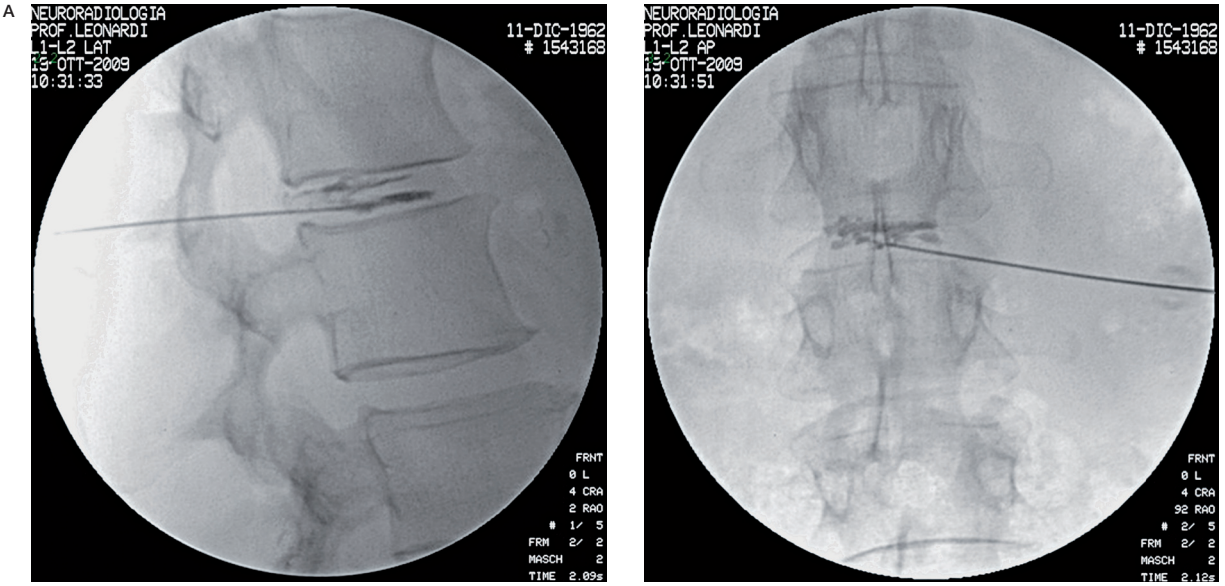

Figure 4 A,B) Right lateral approach to L1-L2 disc in a 47-year-old woman (0.8 ml DiscoGel®).

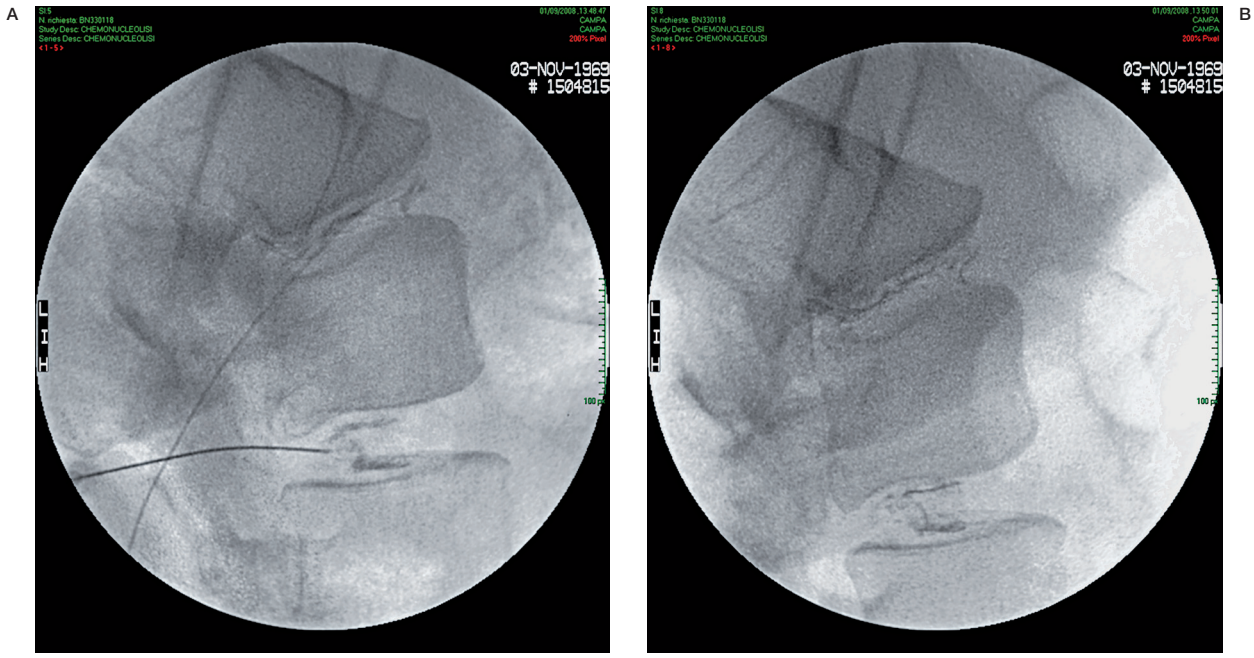

Figure 5 A,B) Left lateral approach to L4-L5 and L5-S1 discs in a 40-year-old man (0.8 ml DiscoGel® × 2).

depo-medrol 40 mg) mixed with anaesthetic (1 ml bupivacaine chlorhydrate 5 mg/ml).

Results

Patients' therapeutic response was calculated at six months after treatment using the modified MacNab method [3] (Table 2). Outcomes were assessed by questionnaire and direct patient interview by an outside observer not involved in patient recruitment or treatment.

The treatment was successful (improvement in pain) in 24 out of 32 patients (75%), whereas it was deemed a failure (mediocre improvement of symptoms – recourse to surgery) in the remaining eight patients (25%). Among the 24 (75%) patients with a successful outcome, results were excellent/good in 14 (43.8%) and satisfactory in 10 (31.2%). Among the eight (25%) failures, treatment was mediocre in five (15.7%) and poor with recourse to surgery in three (9.3%) (Table 3). No treatment-linked complications occurred in any patient.

Thirteen patients underwent discolysis in more than one level. No difference was observed in the results, in comparison to those treated at a single level.

Discussion

Ethanol is well-known to have a lytic and necrotizing effect on biological tissues and has long been used in interventional procedures [1,2,4,7,10]. In the intersomatic disc ethanol produces a molecular scission of proteoglycans and glycosaminoglycans of the nucleus pulposus. This leads to a degradation of these components and a loss of their water-retaining capacity resulting in dehydration and chemical decompression of the disc, thereby alleviating the nerve root compression caused by the herniation [5].

Riquelme et al. [7] demonstrated the advantages of chemonucleolysis with pure ethanol over chemonucleolysis with chymopapain, the main nucleolytic agent used in the past. The benefits include a lack of allergic reactions, no local septic complications, no major pain after treatment, no intersomatic disc narrowing, no aseptic inflammatory complications or "chemical" discitis and a shorter recovery period for patients.

Nevertheless, absolute alcohol does carry major drawbacks [7]: it is not radiopaque and is injected blindly. In addition, procedures need to be carried out under general anaesthesia as they are painful. Ethanol can also indiscrimi-

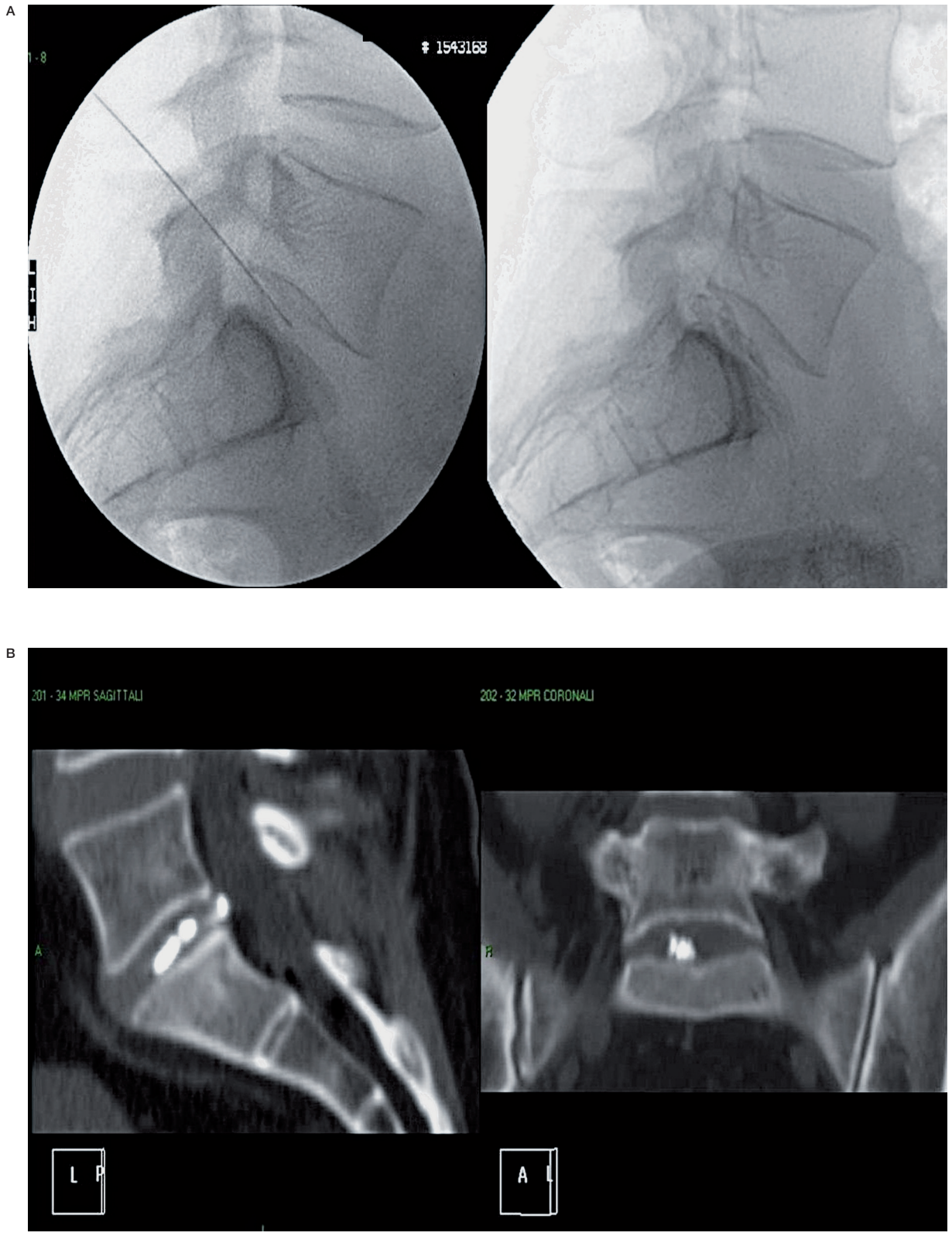

Figure 6 A,B) Right lateral approach to L5-S1 disc in a 52-year-old woman (0.7 ml DiscoGel®).

nately attack the annulus fibrosus, cartilage, vascular walls, nerve structures and the dura. It can also have cytotoxic effects, sclerosis of the vessel wall and thrombosis in all biological tissues, giving rise to severe pain and massive necrosis depending on the amount of ethanol administered.

Discography must be performed before injecting pure ethanol to determine the degree of disc degeneration and any leakage of contrast medium into the epidural space, vascular and intraosseous areas. Therefore absolute alcohol cannot be used if epidural disc tears are disclosed at preliminary discography. In addition there is an absolute contraindication to the use of ethanol in the cervical or thoracic spine due to the difficulty of controlling its diffusion [9].

To overcome the excessive diffusivity of pure ethanol a new substance, DiscoGel®, was recently developed. This radiopaque gelified ethanol has the same chemical characteristics as absolute alcohol but presents two additives highly advantageous in clinical practice [9].

Ethylcellulose: this substance makes the alcohol solution more viscous turning it into a gel which is much easier to control but still injectable through a needle. In contact with the disc the gelified ethanol reacts rapidly becoming a substance with a consistency similar to cotton wool soaked in alcohol. This reaction allows the product to be injected into the disc without leakage into the epidural space or along the nerve roots. In addition, the gelified ethanol remains in the injection site thereby allowing a higher concentration of alcohol in a small amount of injected gel.

Tungsten: to monitor the injection radiologically, the gelified ethanol also contains the powder of an inert metal, tungsten, that makes the product radiopaque. As a result, the injection site and the amount of gel injected can be monitored in real time by radioscopy with no need for preliminary discography. Tungsten also allows excellent gel visibility at CT examination. The radiopaque gel follows the fragile zones of the intersomatic discs, namely any intradiscal tears.

The lack of complications related to ethanol leakage outside the disc in our study confirms that DiscoGel® is safe and easy to handle. In addition, no product visibility problems arose either during the procedure or in subsequent CT follow-up examinations (Figures 4-6).

A 2010 experimental study [5] assessed the impact and morphofunctional changes of intradiscal and intramuscular injection of DiscoGel® in swine. Histopathological analysis of disc specimens 48h after the injection disclosed no morpho-structural changes in the nuclear tissue and annulus.

Compared with findings obtained using other percutaneous techniques, our results with DiscoGel® are satisfactory as the overall therapeutic success rate was similar to that of O_2-O_3 chemonucleolysis (74.3%) [3]. Administering DiscoGel® to patients who had not benefitted from O_2-O_3 therapy also increased the overall success rate of chemonucleolysis (O_2-O_3 and DiscoGel®). The first signs of improvement in our series responding to DiscoGel® chemonucleolysis occurred from two weeks to two months after the procedure.

Some of our patients felt a transient heat sensation in the injection site that subsided as the injection progressed and disappeared when the needle was withdrawn. This sensation has been reported in other cohorts and is probably due to irritation of the intersomatic disc nerve endings [5,8,9]. Although the treatment entails mild pain that may persist for some days, the incidence of patient discomfort can be reduced by injecting the product very slowly.

The negative response to DiscoGel® chemonucleolysis in three of our patients who subsequently underwent surgery had no negative effect on the successful outcome of surgical treatment.

The fact that DiscoGel® chemonucleolysis can be performed on a day hospital basis reduces the cost of treatment even though the procedure remains more expensive than O_2-O_3 chemonucleolysis.

Conclusions

DiscoGel® is safe and easy to handle and there were no complications related to product diffusivity outside the treatment site.

The therapeutic success rate of DiscoGel® chemonucleolysis in patients unresponsive to O_2-O_3 therapy was satisfactory. Among other methods used to treat lumbar disc herniation, DiscoGel® chemonucleolysis can be deemed an intermediate procedure bridging conservative medical treatments and surgery.

As DiscoGel® chemonucleolysis is a more expensive procedure than O_2-O_3 therapy, it is indicated for patients who fail to respond to O_2-O_3 administration before recourse to surgery.

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